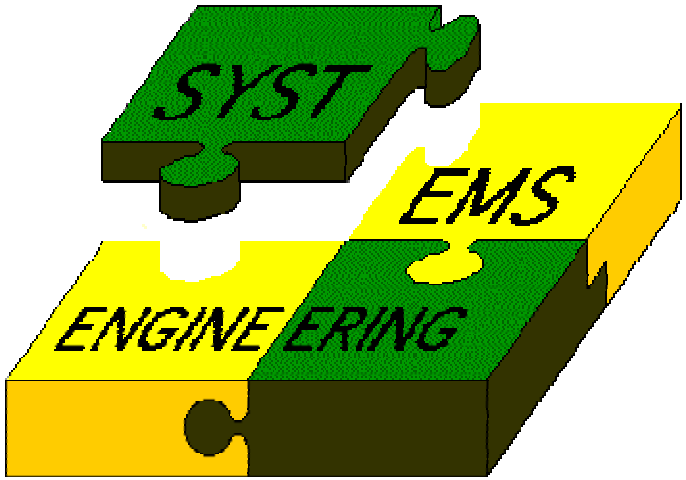

Systems Methodology to Defining Surface Network Architecture

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Presentation Outline

- **Project Overview**
  - **NASA SBT Project**
  - **Objective**
- **Approach**
  - **General Overview**
  - **Applying to Networking**
- **Architecture Definition Performed at NASA GRC**
- **Summary**

Project Overview

- **SBT Project: This work has been done as part of the Space Based Technologies (SBT) Project Surface/Terminal Sub-Element at NASA Glenn Research Center in Cleveland, Ohio. SBT Project has been established within the NASA's Airspace Systems Program and tasked to develop & demonstrate aeronautical CNS and related technologies.**
- **Objective: Analyze network and applications requirements and define a *surface network architecture* that is scalable, reliable, secure and flexible:**
  - **To meet the current and future surface communications needs.**
  - **To enhance the safety and efficiency of operations of airport.**
- **Team: NASA and Contractors.**

State of Existing Surface Network

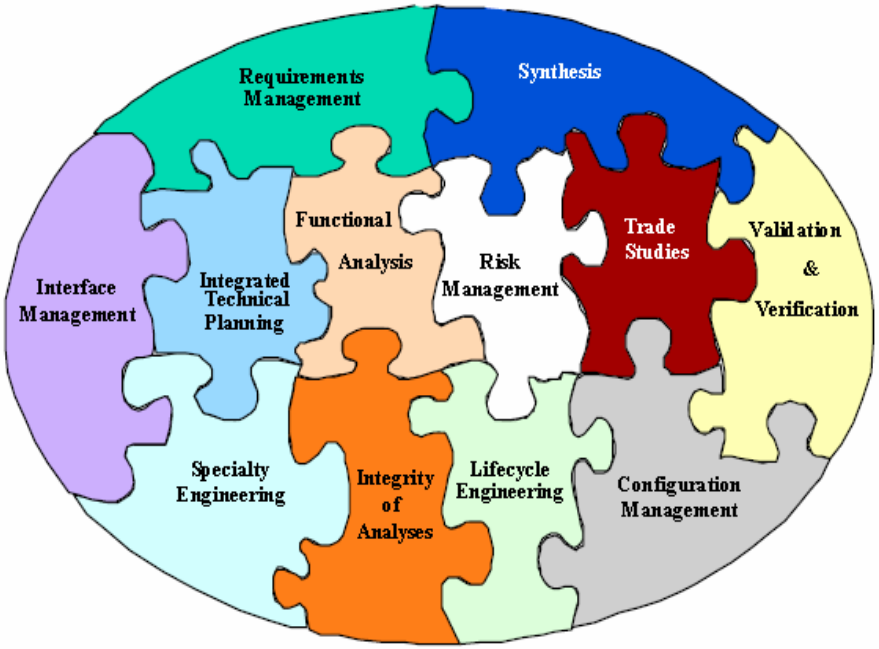
- **Current state of most modern airports' surface network is fragmented, lack of information sharing, or non-interoperable among surface communication systems.**
- **Personnel managing surface traffic movement (of aircraft & other vehicles), for example, need accurate and complete information on traffic locations & intentions, especially at night and low-visibility.**
- **Need a systematic approach to defining a surface ICNS network architecture that is scalable, reliable and flexible to meet current and future needs of airports' operations, especially post-911 environment.**

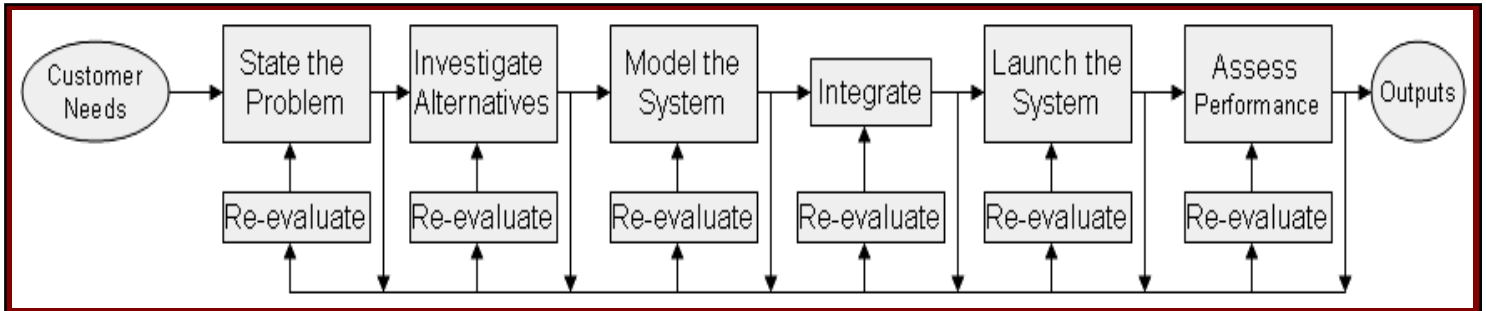
Approach: Systems Engineering (SE)

- **In General:**
  - **FAA NAS SE Manual: SE is an overarching process that trades off and integrates elements within a system's design to achieve the best overall product and/or capability known as a system.**
  - **INCOSE: SE is an engineering discipline whose responsibility is creating and executing an interdisciplinary process to ensure that the customer and stakeholder's needs are satisfied in a high quality, trustworthy, cost efficient and schedule compliant manner throughout a system's entire life cycle.**

SE Process

12 SE Elements
Process Lifecycle

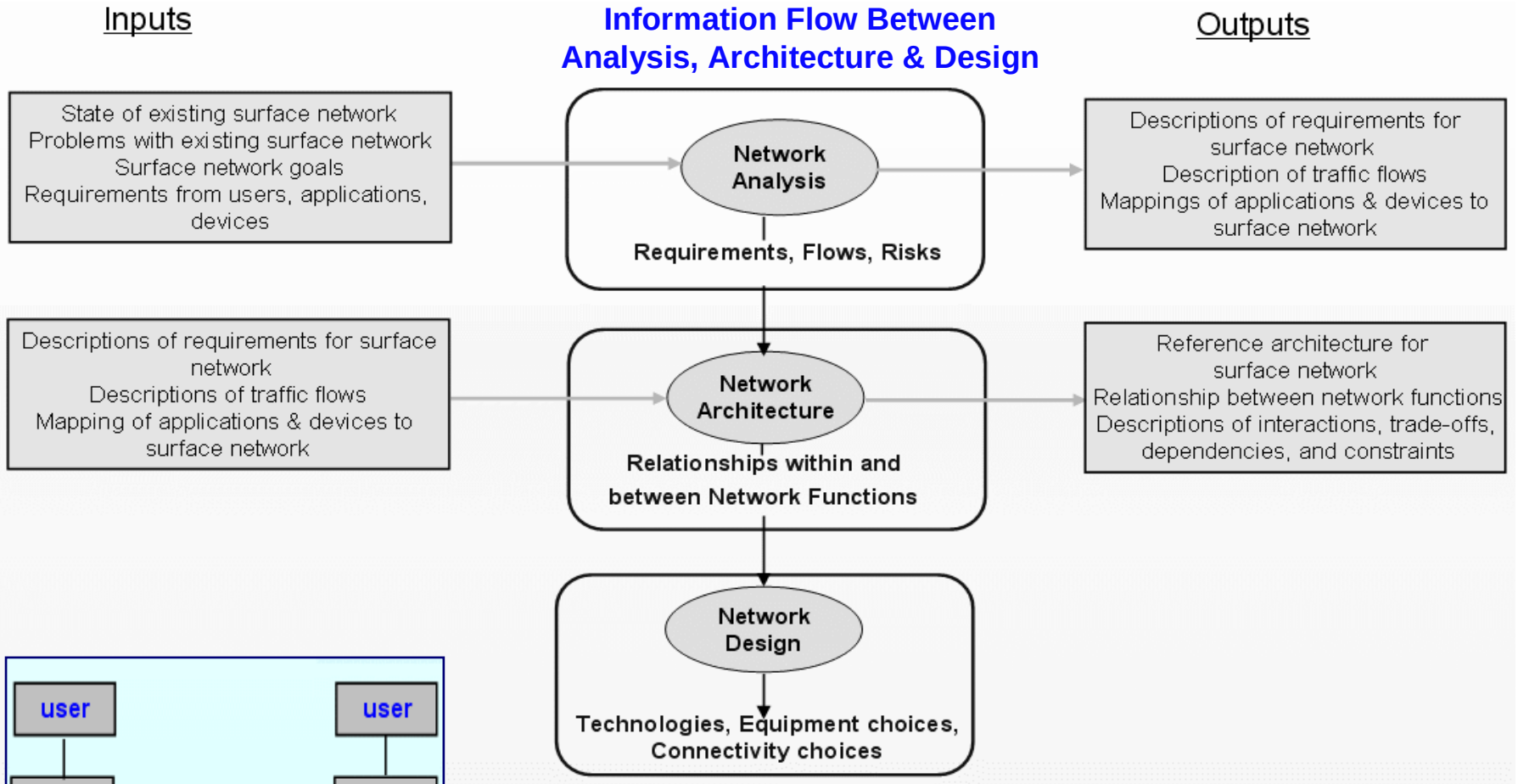


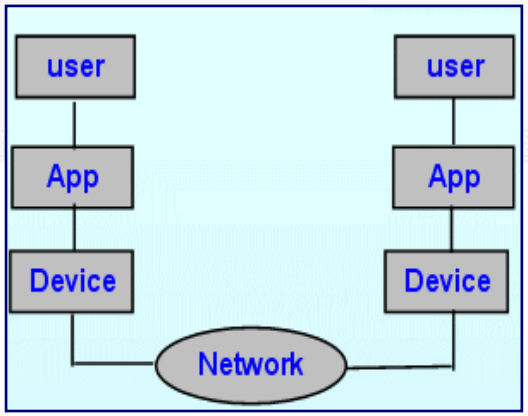


INCOSE
International Council on Systems Engineering

The SIMILAR Process

Applying Systems Methodology to Networking





Example: Generic components of a system

Note: (1) Systems methodology (as applied to networking) is viewing the network that one is architecting and designing, along with subset of its environment, as a system.

(2) A system is a set of components that work together to support or provide connectivity, communications, and services to users of the system.

Comparison Between Architecture & Design

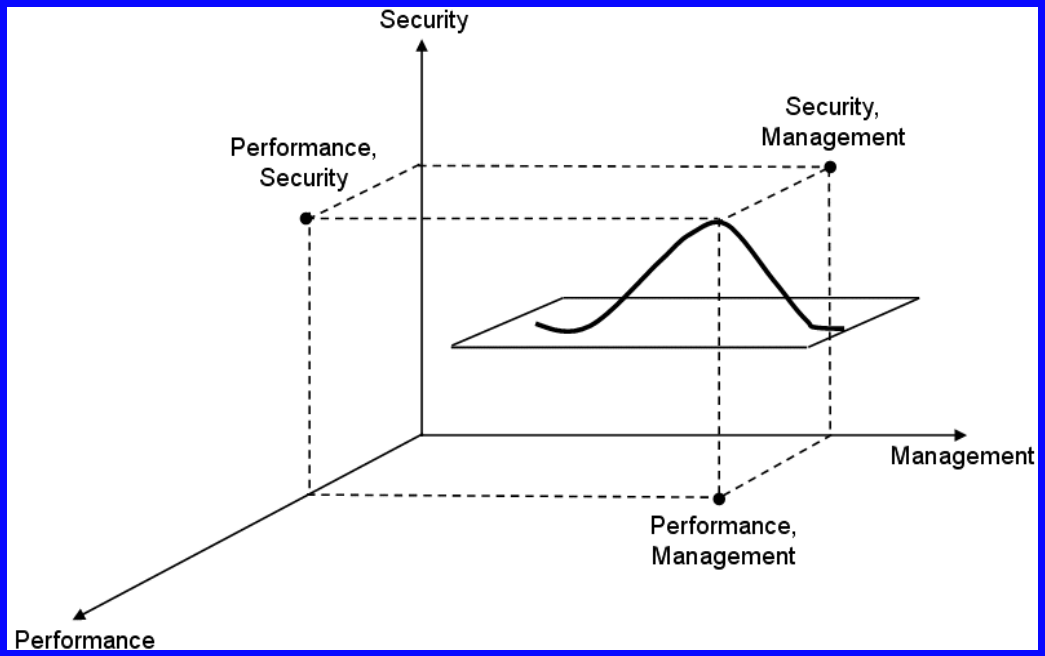
Difference:

	Network Architecture	Network Design
Scope	*Broad*	*Focused*
Level of Detail	*Generalized*	*In depth*
Description	*Relationships*	*Technologies*
Location	*Independent*	*Dependent*

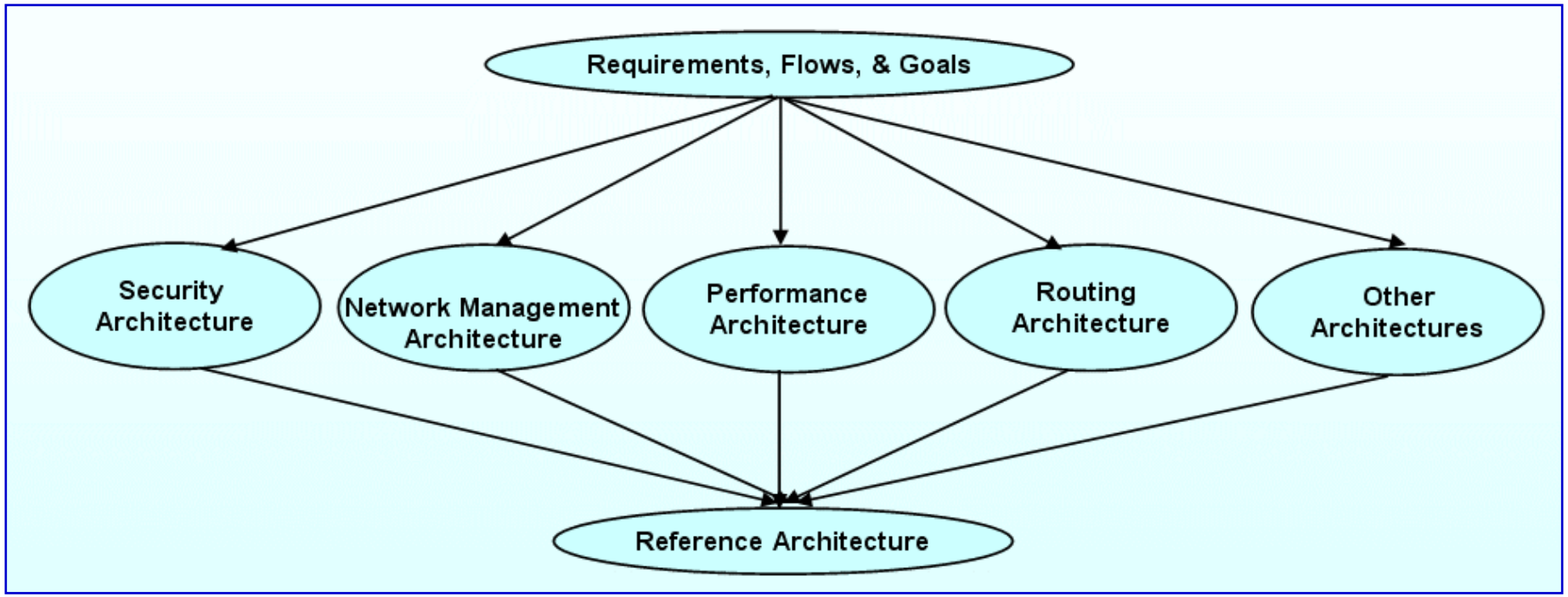
Similarity:

Multidimensional Solutions

Multidimensional Solutions



Component Architectures & Functions (1/2)

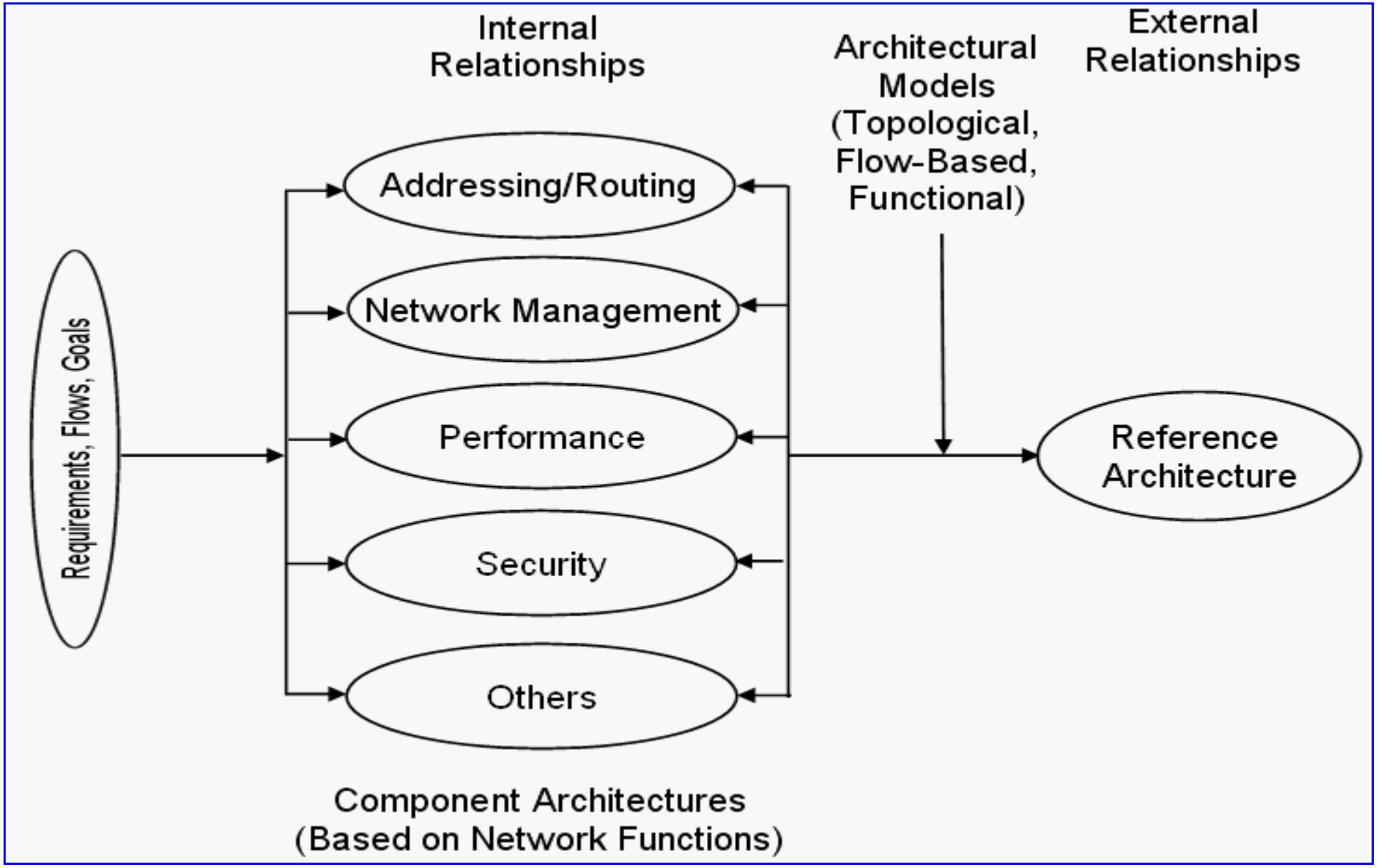


Note: Component architectures & reference architecture are derived from requirements, estimated traffic flows and goals defined for each network.

Component Architectures & Functions (2/2)

Function	Description of Capability	Mechanisms Used to Achieve Capability
Addressing/Routing	*Providing robust and flexible connectivity between devices*	*Addressing: address space allocation & aggregation* *Routing: routers, routing protocols, manipulation of routing flows*
Network Management	*Providing monitoring, configuring, and troubleshooting for the network*	*Network management protocols* *Network management devices* *Ways to configure network management in the network*
Performance	*Providing network resources to support requirements for capacity, delay, and RMA*	*QoS* *SLA* *Policies*
Security	*Restricting unauthorized access, usage, and visibility within network to reduce threats and effects of attacks*	*Firewalls* *Security policies and procedures* *Filters and access control lists*
Other	Additional capabilities to meet current and future needs	To be defined as additional functions added

Network Architecture Process

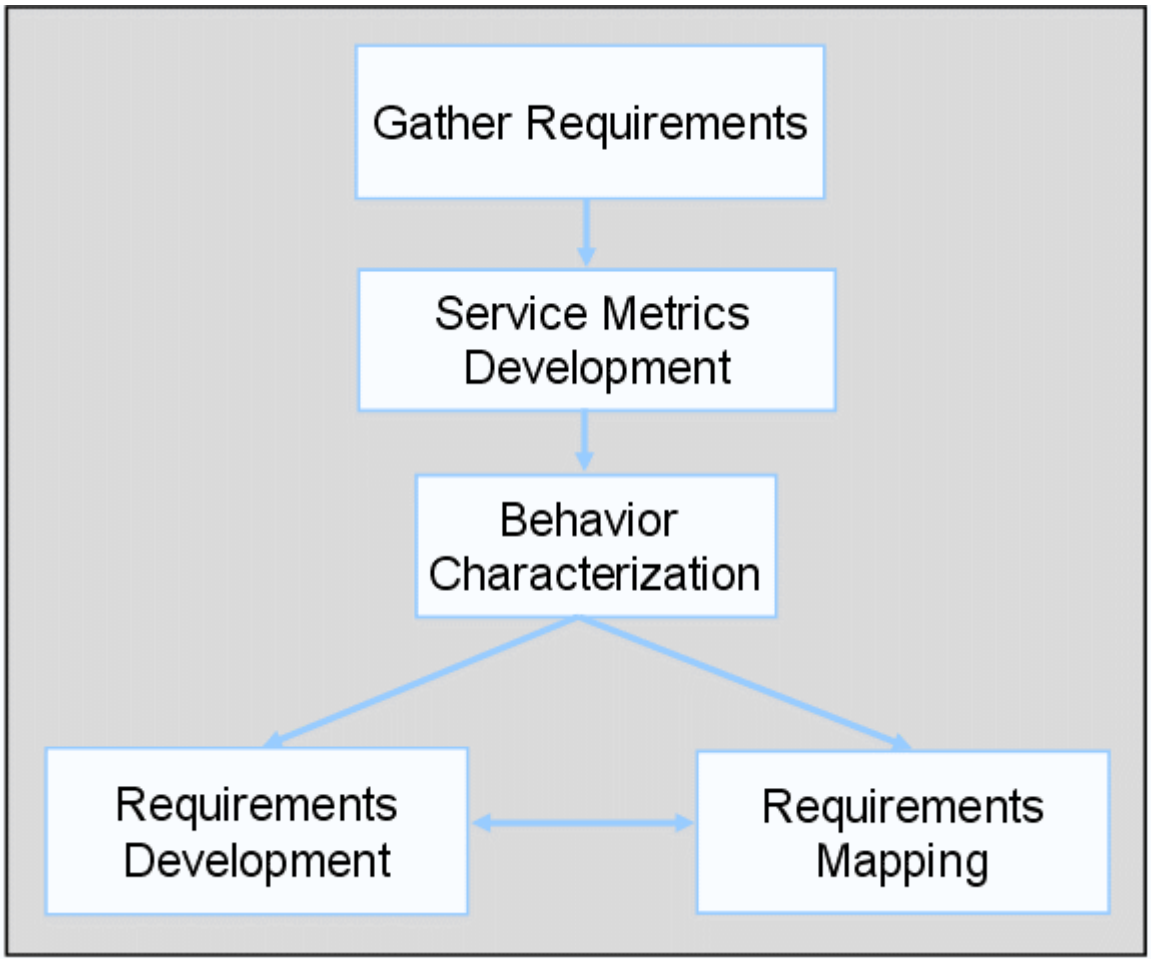


- **Surface ICNS Network Architecture Definition Being Performed at NASA GRC**

Requirements Analysis

- **Requirements:**
  - **User**
  - **Applications (types, groups and locations)**
  - **Device (types, characteristics and locations)**
  - **Network**
  - **Other**
- **Requirements Analysis Process Model**
- **Modeling & Simulation**

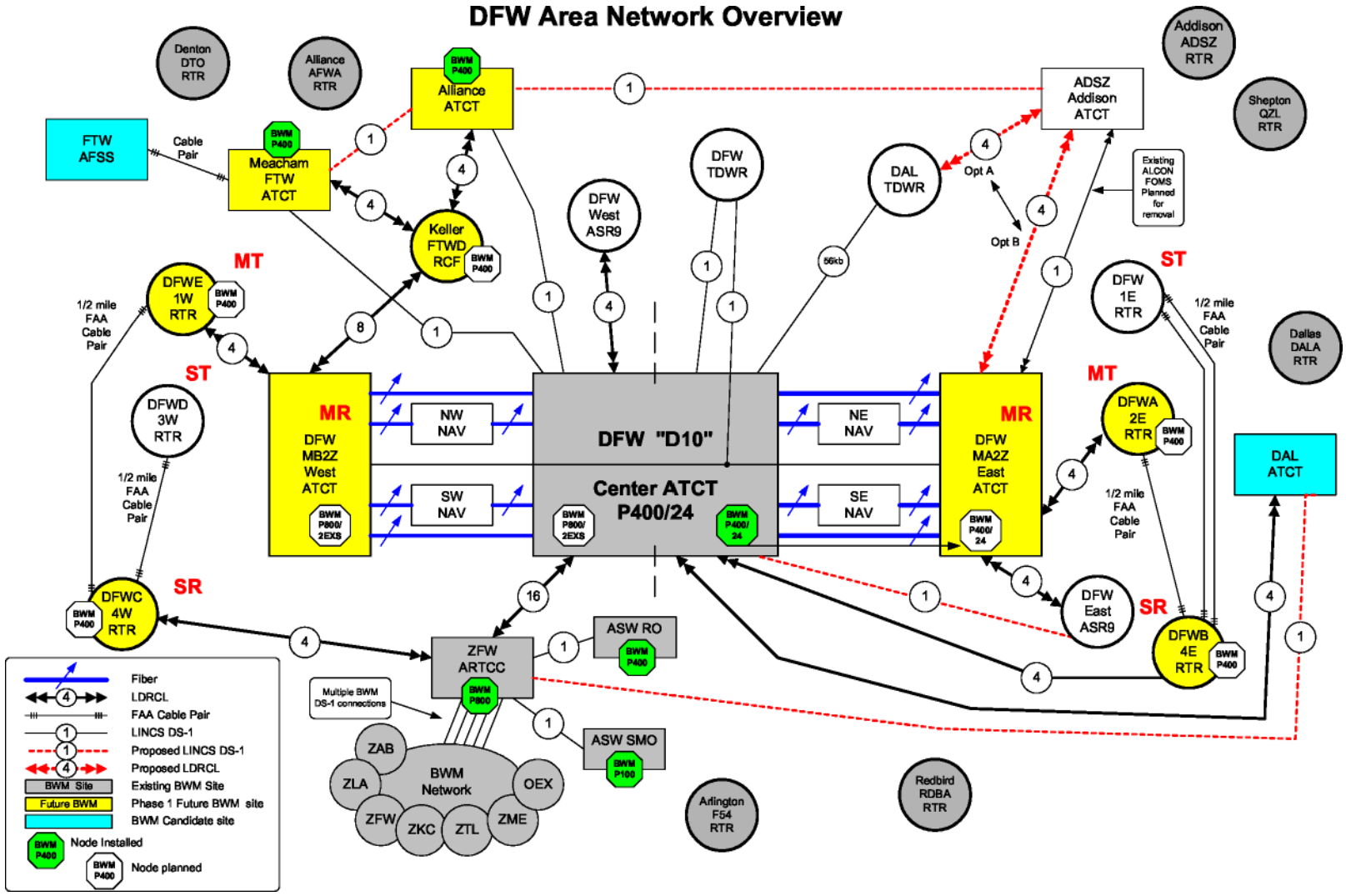
Process Model for Requirements Analysis



Requirements Gathering

- **"Trios Report" -- SAIC Aviation Sciences Operation, SEAS Business Unit (Formerly Trios Associates, Inc.) was tasked to gather the Surface CNS Network Requirements for NASA GRC:**
  - ***Airline Operations Communications Systems***
  - ***FAA Communications***
  - ***Airport Operations Communications Systems***
  - ***Tenant Communications Systems***
  - ***Existing Systems Assessment***
  - ***Current Wireless Systems***
  - ***Services Description & Evaluation***
- **Surface Applications Requirements Analysis performed by a team of NASA GRC and onsite contractors**
- **Airport Visits Being Planned**
- **Modeling & Simulation**

Example of FAA Communications at DFW



Source: Provided by SAIC to GRC

Surface Applications Requirements Analysis

- **Air Traffic Management (ATM)**
- **Aeronautical Operational Control (AOC)**
- **Airline Administrative Communications (AAC)**
- **Airport Operation Communications**
- **Airline Passenger Communications (APC)**
- **Other Communications**

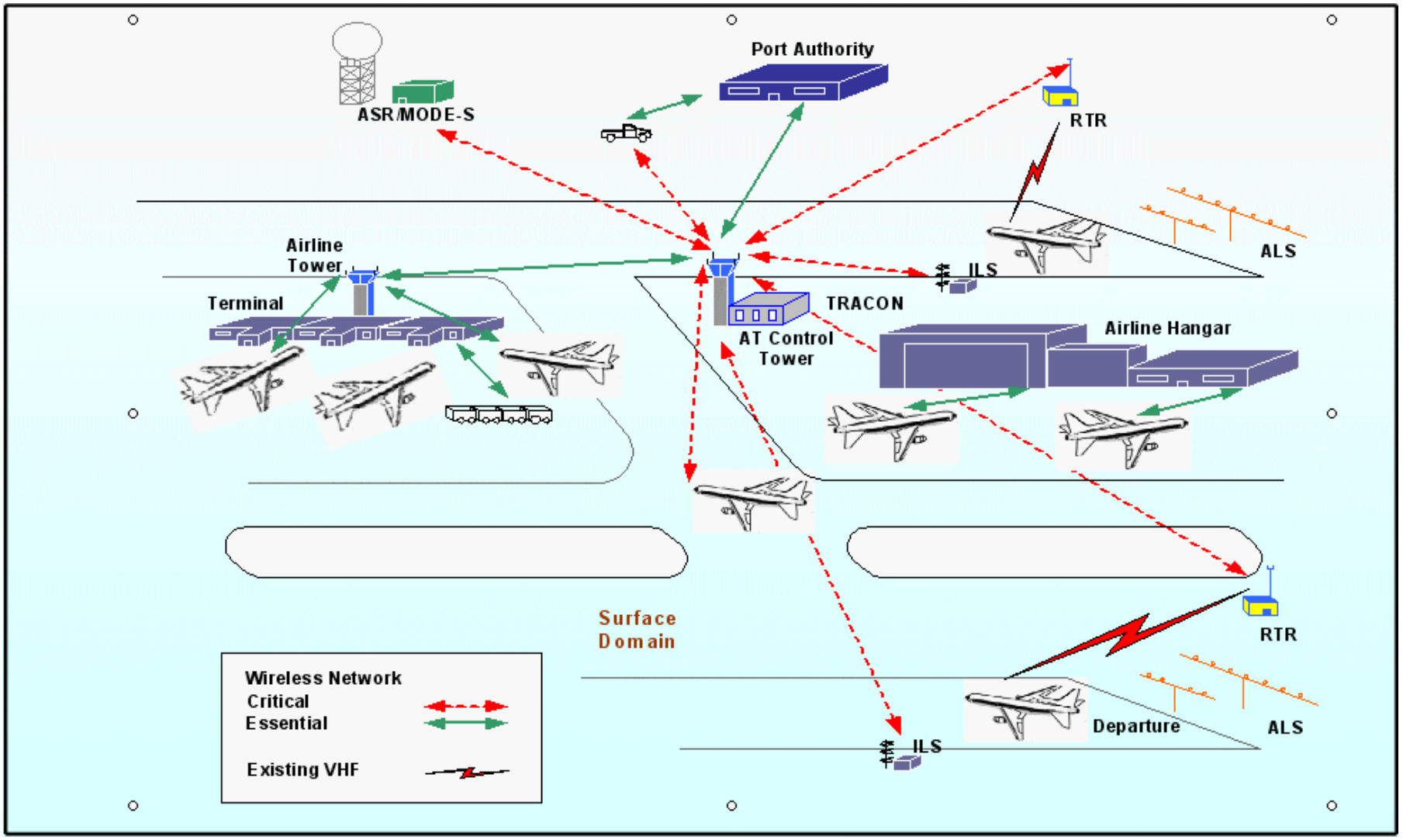
Air Traffic Management (ATM)

- **Current ATM**
  - **Pilot/Controller Communications**
    - » **Pre-departure Clearance (PDC)**
    - » **Taxi Clearance**
    - » **Oceanic Clearance**
  - **Context Management (CM)**
  - **Airport Terminal Information (ATIS)**
  - **Notice to Airmen**
  - **RTR**
  - **TDLS**
  - **Etc.**
- **Future ATM**
  - **CPDLC**
  - **Automatic Downlink of Airborne Parameters (ADAP) Services**
  - **Data Link flight Information Services (D-FIS)**
  - **Etc.**

Example of ATM/ PDC Communications Characteristics

#	Parameter	Value	Future
1	**Information Unit Size (uplink/downlink)**	**(1800 / 304) bits**	
2	**Occurrence (uplink/downlink)**	**(1.25 / 2.25) msg/flt**	
3	**Required Response or Delay Time**	**5 min**	
4	**Estimated bandwidth required**	**1,200 bps**	
5	**Precedence**	**None**	
6	**Integrity Required (Undetected Error Rate)**	**$< 10^{-6}$**	
7	**Availability**	**95 - 98%**	
8	**Encryption**	**No**	
9	**Authentication**	**No**	**Yes**
10	**Communication links used**	**VHF voice / ACARS**	**FCS**
11	**Source/Destination**	**Cockpit/ATC**	

Potential Wireless Surface Communications Network



Courtesy of Rafael D. Apaza of FAA Air Traffic Organization

Summary

- **A systematic approach to define Surface ICNS Network Architecture has been presented.**
- **This scalable, reliable and flexible surface network architecture, when completely defined, can potentially meet the current and future surface communications needs and can enhance the safety and efficiency of operations of airport.**
- **Still More work to be done.**

THE END

Thank You!